LCCN 85-931448

ISSN: 1023-1072 (Print), ISSN: 2663-7863 (Online)
https://doi.org/10.47432

PAKISTAN JOURNAL OF AGRICULTURE AGRICULTURAL ENGINEERING AND VETERINARY SCIENCES

An Official International Biannual Publication of Sindh Agriculture University Tandojam, Pakistan

Volume 39 (2) December, 2023

SINDH AGRICULTURE UNIVERSITY TANDOJAM

http://pjaaevs.sau.edu.pk/index.php/ojs

Pak. J. Agri., Agril. Engg., Vet. Sci., 2023, 39 (2): 141-148
ISSN: 1023-1072 (Print), ISSN: 2663-7863 (Online)
https://doi.org/10.47432/2023.39.2.9

IMPACT OF CLIMATE CHANGE ON AGRICULTURAL PRODUCTIVITY IN SINDH PROVINCE OF PAKISTAN: ANALYSIS OF MAJOR CROPS IN EIGHT DISTRICTS

A. A. Joyo[*1], Z. H. Channa[2], M. B. Khan[3], A. S. Joyo[2] and N. A. Bhutto[4]

[1]Planning and Development, Quaid-e-Awam University of Engineering, Science and Technology, Nawabshah, Pakistan
[2]Shaheed Benazir Bhutto University, (SBA) Nawabshah, Pakistan
[3]National Defence University, Islamabad, Pakistan
[4]PhD Scholar, Sindh Development Studies Centre, Jamshoro, Pakistan.

ABSTRACT

The objective of this study is to analyze the situation of major crops cultivated in Sindh province of Pakistan. The current study is based on secondary sources of data of the major crops such as wheat, cotton and sugarcane cultivated in different zones of Sindh province for instance upper, middle and lower Sindh.The discripitve analysis of study shows the cultivation area and production of three major crops such as wheat, cotton and sugarcane. High productivity of wheat was recorded in the districts of Khairpur, Ghotiki, Shaheed Benazirabad, Dadu and Mirpurkhas whereas low production of this crop was observed in the districts of Larkano, Badin and Tando Muhammad Khan. The production of cotton in the districts of Ghotiki, Khairpur, Shaheed Benazirabad, Tando Muhammad Khan and Badin was higher than the Dadu and Larkano districts. The situation of sugarcane crop remained better in the districts of Ghotiki, Shaheed Benazirabad, Badin, Tando Muhammad Khan and Mirpurkhas while two districts i-e Larkano and Dadu had less product of this crop. Average production of wheat stood 228,328.78 million tons (Mt) against cultivation of area 65,353.47 hectares. The average yield of cotton remained 216,829.92 bales against average cultivation area of 37,430.18 hectares. Average product of sugarcane recorded 1,381,970.18 Mt against average cultivation of area 22,763.13 hectares in eight selected districts of Sindh province during the period 2015-16 to 2019-20. The regression analysis of the time series data shows that temperature has significant effect on the productivity of the selected crops (i-e) wheat, cotton and sugarcane. While the rainfall has no significant effect on the productivity of the selected crops. The study suggests that government should concentrate to provide more facilities to growers in shape of small loans, subsidies, fertilizers and sufficient water during crops rotations. Moreover, the agriculture sector needs consistent policies to ensure rural employment.

Keywords: agricultural productivity, climate change, cultivation, major crops

INTRODUCTION

Pakistan has geographical area of 79.61 million heactares and its total cultivation of area is 22.74 million heactares (ASP, 2019-20). Agriculture sector in Pakistan has great importance as it contributes 22.7% in Gross Domestic Product (GDP) and provides employmet to 38.5% of the labour force. About 70 percent of the population directly or indirectly depends on this sector for their livelihood. This sector has been facing many challenges such as changes in climate, temperature and precipitation, lack of water and increase in input prices (GoP, 2020-21 and 2021-22). Pakistan's agriculture sector has five sub-sectors such as major crops, minor crops, livestock, fisheries, and forestry. The share of major crops in Gross Domestic Pproduct (GDP) is greater than other crops (Zaidi, 2015). Cropping combinations of various major crops in irrigated areas of Pakistan are Wheat-maize (Khyber Pakhtunkhwa), rice-wheat (Punjab), mixed-wheat (Punjab), cotton-wheat (Punjab), sugarcane-wheat (Punjab) cotton-wheat (Northern and Southern Sindh), rice-wheat (Northern and Southern Sindh) (Aslam, 2016). Pakistan has two cropping seasons summer (Kharif) and winter (Rabi), important crops of these two seasons are wheat, cotton, rice,

*Corresponding author: aajoyo14@yahoo.com

sugarcane and maize. The contribution of these important crops and other crops in GDP was 4.41% and 3.14%, respectively. Crop-wise, the share in GDP has been recorded as wheat (1.8%), cotton (0.6%), rice (0.5%), sugarcane (0.8%) and maize (0.7%) during the period 2021-22. Sugarcane production increased from 81.0 million tons to 88.7 million tons (Mt) during 2021-22, its cropped area also increased at 8.2% from 1165 (000) hectares in 2020-21 to 1260 (000) hectares, cotton production increased from 7.1 million bales as reported in 2020-21 to 8.329 million bales in 2021-2022 although decreased in cropped area from 2079 (000) hectares in 2020-21 to 1937 (000) hectares in 2021-22. While the production of wheat decreased to 26.4 million tons from 27.5 million tons because of decline in cropped area, lack of irrigation water and offtake fertilizer, waves of heat in the month of March and April 2022. (GoP, 2020-21 and 2021-22). The above fluctuation in production of major crops was mainly due to change in climate, precipitation and timely supply of irrigation water in the country. According to the Multi-Model Data regional climate model, South Asia's average annual temperature would rise by 3.3 0 by the end of the twenty-first century, as this was discussed in the Intergovernmental Panel on Climate Change's 5th annual report. (ZTBL, 2020).

Total area of the Indus Basin is 566000 km^2 and the Indus River System is called main source of life in Pakistan, it supplies water about 90% of Pakistan's food production and provides 25% to the GDP of Pakistan. According to the World Bank study for 2020-2021, the water shortfall is expected to reach 32% by 2025, leading to a food shortage of about 70 million tons and the capacity of water storages would be reduced by siltation and climate at 30% by the end of 2025. (Janjua *et al.*, 2021). Climate change would negatively affect agriculture and its related sub-sectors, such as livestock, fisheries, water resources/glaciers, and forests, putting Pakistan at risk due to worldwide changes in climates. (Saif, 2017). The impact of climate change on Pakistan's key crops like wheat, rice, sugarcane and maize, including maximum and minimum temperatures, rainfall, relative humidity, and sunshine. Climate change is putting Pakistan at risk, and extreme weather is endangering food security. The impact of minimum temperature is favourable and significant for all crops, and the maximum temperature has a negative impact on wheat crop. Except wheat crop, rainfall has also negative impact on other crops' production (Ali, *et al*., 2017). Water will become a more limited resource for farmers as temperatures rise and precipitation patterns change, threatening both the occupations and food security of farmers in the Indus basin as well as Pakistan's overall food security (Kamenev, 2014). The ability of natural resources (biodiversity, soil, and water) to meet the world's rising food demand is being negatively impacted by climate change. Therefore, it is necessary to address both the issues of food security and climate change simultaneously. (FAO, 2009). Weather and climate change have a direct impact on agricultural production. Kumar, 2020 indicated that according to IMF analysis of 2017, a 1^{o}C increase in temperature would cut agricultural production by 1.7% and a 100mm decline in precipitation would decrease growth by 0.35% for rising market countries. According to the study conducted by (Sheikh, *et al*., 2019) their study revealed that by 2050, global climate change will result in a decline in agricultural output, a rise in food prices, and an increase in cultivated land. The primary source of income for those living in rural areas is agriculture, which is mostly dependent on climatic factors and other resources. Therefore, any change in the weather or climatic conditions may have an adverse effect on the farming populations' health and attitude in addition to disrupting their income. The major five crops like wheat, rice, cotton, sugarcane, and maize are harvested in Pakistan, and these crops are being affected by climate change. (Syed, *et al*., 2022). Key crops, including wheat, maize, cotton, rice, and sugarcane, are at risk due to climate change. By 2040, temperatures are expected to increase by 3°C and by the end of the century; temperatures are projected to rise by 5-6°C, which will lead Asian countries to lose up to 50% of their wheat production (Ghanem, 2010). Agricultural output will be declined about 8 to 10% because the temperature is going up by 2040, it is expected (Cradock-Henry *et al*., 2020). Climate change will be one of the most reason in decreased crop yields in developing countries. The consequences of climate change on irrigated yields will vary by region, but South Asia will see significant losses in irrigated yields for all crops. As a result of climate change, the most significant agricultural crops-wheat, rice, maize, and soybeans-will see more price hikes. Meat prices will increase as feed costs rise. (Nelson *et al*., 2009). The average increase in temperature

will be 2.8ºC worldwide, ranging from 1.8ºC to 4ºC (Solomon *et al.,* 2007) compared to advanced countries, low-income developing countries will see more impact from rising GHGs on agriculture farms (Kurukulasuriya *et al.*, 2006; Seo and Mendelsohn, 2008). Due to its great reliance on weather and climate, Agriculture sector is at risk from climate change and individuals who work in it often earn less than people who live in cities. Agricultural activity results in a significant discharge of greenhouse gases (GHG) into the atmosphere. (ADB, 2009). The maximum declines in agricultural potential are anticipated to occur in developing nations in Asia and the Pacific because of climate change. Climate change will thus make it harder to achieve long-term development objectives in Asia and the Pacific. Many of the countries in the region are already facing difficulties due to the region's slow agricultural output growth, decreasing income growth, and issues with preserving food security. Unprecedented climate change is the world's biggest environmental problem today. Global climate change is seriously harming both people and wildlife. Over 1,300 experts from the United States and other nations make up the Inter-Governmental Panel on Climate Change (IPCC), which projects that global temperatures will raise by 2.5 to 10 degrees Fahrenheit over the next century. (GoP, 2016). Global warming will cause a major reduction in world agriculture this century. By 2080, it is anticipated that global agricultural productivity will have decreased anywhere between 3 and 16 percent. The 2080s are expected to see an average 10 to 25 percent reduction in agricultural productivity in developing countries, many of which currently have average temperatures that are close to or above crop tolerance levels. (Mahato, 2014). Changing weather patterns would also affect the arid Punjab region. The forecast for the future showed a decline in net revenues, and the temperature increase has caused a sharp decline in net revenues. Due to their small land holdings, farmers in dry areas are now more vulnerable due to the rising temperatures. A rise in temperature will consequently result in an increase in poverty for both the farming community and the region as a whole due to the dry, arid land. (Shakoor *et al.,* 2011).

Previous studies have investigated the impact of climate changes on the crop production of the different areas around the world. The results of these studies have brought mixed results.

Climate and cropping zones in Sindh Province

The total geographical area of Sindh province is 140900 square kilometers and lies between 23 and 29ºC north latitude and 67 and 71ºC east longitude. The climate condition of Sindh province is hot and it has three zones (1) Costal: South of Thatta (2) Southern: from Thatta through Hyderabad to Nawabshah (3) Northern: from Nawabshah to Jacobabad. Different areas are suitable for different crops such as Khairpur, Nawabshah, Hyderabad, Sanghar and Mirpurkhas are the appropriate districts for cotton and wheat crops, while Larkano is suitable for growing rice crop and Badin and Tando Muhammad Khan are appropriate for rice and sugarcane crop.

By the end of the twenty-first century, temperature might be increased by 2 to 5ºC, this would depend on emissions and scenarios. Due to climate change, it is expected that household income and agricultural output will decline. (Lohano and Mari, 2020). Climate change poses a challenge to agriculture, which is essential for producing food; we all need and depend on it for our food. There is little doubt that systems around the world will need to adjust, but millions of people in underdeveloped nations face a very serious and direct threat to their food security and way of life, while consumers in rich countries may not notice (Moorhead, 2009). The climate in Sindh as well as Punjab province is sub-tropical, with an average annual rainfall of 200mm at its highest point, summertime temperature reaches up to 46°C, and in wintertime it reaches 2°C. The left bank and right bank of the Indus Basin River serve as a good marker for the different crop zones in Sindh. The cotton-wheat and sugarcane mix zone is located on the left bank, while the rice-wheat zone is located on the right bank. By raising temperatures and lowering precipitation amounts, climate change impacts in Punjab and Sindh provinces' irrigated areas may result in a rise in crop water requirements. The area that is irrigated may decrease because of this shortage in water supply. Furthermore, cropping zones and areas as stated by the authors as cotton-Wheat zone (Larkano, Rohri, Sakrand and Khairpur), Rice-wheat zone (Dadu and Larkano), Sugarcane mix zone (Padidan, Mirpurkhas and Tandojam) (Hasan *et al*., 2021). One of Pakistan's four provinces, Sindh is located on the lower side of the Indus River and on the eastern side of the Arabian Sea. Sindh experiences tremendously little rainfall and an

arid climate. The Rabi is the period from October to March, and the Kharif is from April to September. About 150 mm of rainfall every year on average, with more falling from July to September, primarily during the monsoon season. Due to glacial meltwater during periods of low precipitation, the Indus River capabilities a modest annual Variation in water volume. But during periods of heavy precipitation, water availability varies greatly from season to season. Floods frequently occur and which is caused of a big loss (JICA, 2022). Under the climate risk situations, negative effects are expected, and it is predicted that Gross Domestic Product (GDP)-1.1%, Agriculture to GDP -5.1% and household income -2.0% will all decline on average annually basis. The Sindh crop production is most affected, with an average impact of about 10%. The most sensitive crops to climate change were irrigated rice, sugarcane, cotton, and wheat. These crops also revealed the most dynamic responses to changes in water supply and price (Winston, 2013). According to the results of the majority of climate models, Sindh province's mean daily temperatures will rise approximately 5°C throughout the 21st century, which is around 1°C less than Pakistan's northern areas. The mean daily temperatures are projected to range from 26 to 27°C Celsius along Sindh's coastal strip, from 27 to 28°C Celsius in the province's centre, and from 27 to 29°C Celsius in upper Sindh over the next 20 years. Any change in temperature causes the echosystem to change in complex ways (Rasul *et al.*, 2012). Changes in temperature and precipitation have a negative impact on Pakistan's agriculture sector, climate change has also a negative impact on the growth, maturity, and production of cotton plants as well as the means of survival for farmers. (Ali *et al.,* 2021). This study covers 8 out of 29 districts of Sindh province i-e Ghotki, Khairpur, Shaheed Benazirabad (SBA), Mirpurkhas, Larkano, Dadu, Tando Muhammad Khan and Badin to analyze the area and production of major crops like wheat, cotton and sugarcane cultivated in these districts during the period from 201516 to 2019-20.

MATERIALS AND METHODS

Place of study

In this study eight selected districts of Sindh province of Pakistan namely Badin, Ghotki, Khairpur, Mirpurkhas, Saheed Benazirabad, Dadu, Larkano, Tando Muhammad Khan were selected.

Source of data

In this study data about production of major crops was collected from 8 selected district of Sindh province. Data were taken Agricultural Statistics of Pakistan, Agriculture, Supply and Prices Dept. Government of Sindh, Economic Survey of Pakistan, as well as from national and international journals. The present study covers the period of 5 years from 2015-16 to 2019-20. The district-wise data (area and production) of major 3 crops were collected from Development of Statistics, Goverent of Sindh, 2021.

Statistical methods

In this study descriptive statistics were applied to the data to determine the average, sum, percentage of sum, standard deviation, range, minimum and maximum area and production of major 3 crops. Statistical Package for Social Sciences (SPSS-20) was used. Furthermore, the time series data was analysed using regression model through Eviews software.

RESULTS AND DISCUSSION

District-wise area and production of major crops

The area and production of three major crops such as wheat, cotton and sugarcane cultivated in 8 selected districts of Sindh province were analyzed and presented in Tables 1 to 6 during 5 years period from 2015-16 to 2019-20. Tables 1 and 2 indicate total wheat production 9,133,151 Mt against the cultivation of area 2,614,139 hectares in 8 districts of Sindh province during the period from 2015-16 to 2019-20. The district-wise production of wheat recorded as in Khairpur (1,946,986 Mt), Ghotki (1,888,367 Mt), SBA (1,740, 203 Mt) Dadu (1,215,256 Mt) and Mirpurkhas (875,083 Mt) stood at 21.3, 20.7,19.1,13.8 and 9.6% respectively. The less product of wheat was produced in the districts of Tando Muhammad Khan (216,801Mt) Badin (437,744 Mt) 2.4 and 4.8% respectively. Average product of wheat recorded 228,328.78 Mt against average cultivation of area of 65,353.47 heactares in these 8 distircts. In Pakistan, wheat and rice are considered the main crops and it was reported that 14.7 and 20.5 % production decreased by climate change in the past few years (Haq et al., 2021). Crops are extremely affected by water quantity, water quality and temperature fluctuations in irrigated and spate farming (Syed et al., 2022). It was predicted by Henry et al. that due to increased temperature the agriculture production will be reduced 8-10 % up to 2040 (Cradock-Henry et al., 2020).

Table 1. Area analysis of wheat crop during 2015-16 to 2019-20 in 8 districts of Sindh Province

(Area in hectares)

District Name	Minimum	Maximum	Range	Mean	Std. Deviation	Sum	% of Total Sum
Ghotiki	101999	109000	7001	106094.20	3510.034	530471	20.3%
Khairpur	102101	105212	3111	103988.80	1173.681	519944	19.9%
SBA	84354	88554	4200	87120.40	1651.410	435602	16.7%
Mirpurkhas	35410	64908	29498	54925.20	13199.167	274626	10.5%
Larkano	49231	52051	2820	50656.20	1273.824	253281	9.7%
Dadu	73400	75978	2578	74917.20	1120.235	374586	14.3%
Tando Muhammad Khan	12035	15308	3273	14187.80	1314.290	70939	2.7%
Badin	19770	40825	21055	30938.00	8377.309	154690	5.9%
Total	12035	109000	96965	65353.47	32139.940	2614139	100.0%

Source: author's Calculations based on Development Statistics of Sindh, 2021

Table 2. Production analysis of wheat crop during 2015-16 to 2019-20 in 8 districts of Sindh Province

(Production in Mt)

District Name	Minimum	Maximum	Range	Mean	Std. Deviation	Sum	% of Total Sum
Ghotiki	340769	393425	52656	377673.40	21682.317	1888367	20.7%
Khairpur	377007	413943	36936	389397.20	14931.873	1946986	21.3%
SBA	320296	368693	48397	348040.60	19665.109	1740203	19.1%
Mirpurkhas	112002	212995	100993	175016.60	39767.807	875083	9.6%
Larkano	137025	201406	64381	162542.20	26314.229	812711	8.9%
Dadu	225621	259596	33975	243051.20	15034.919	1215256	13.3%
Tando Muhammad Khan	38431	50144	11713	43360.20	4465.331	216801	2.4%
Badin	59948	117024	57076	87548.80	24315.855	437744	4.8%
Total	38431	413943	375512	228328.78	127776.716	9133151	100.0%

Source: author's Calculations based on Development Statistics of Sindh, 2021

Table 3. Area analysis of cotton crop during 2015-16 to 2019-20 in 8 districts of Sindh Province

(Area in hactares)

District Name	Minimum	Maximum	Range	Mean	Std. Deviation	Sum	% of Total Sum
Ghotiki	82970	97434	14464	91958.80	5948.056	459794	30.7%
Khairpur	58382	84613	26231	77563.20	10828.443	387816	25.9%
SBA	52197	64500	12303	60215.40	5604.954	301077	20.1%
Mirpurkhas	14175	39345	25170	31745.20	10803.681	158726	10.6%
Larkano	0	1875	1875	1343.20	760.164	6716	0.4%
Dadu	8840	12181	3341	10244.40	1445.734	51222	3.4%
Tando Muhammad Khan	2710	22841	20131	11123.80	10597.481	55619	3.7%
Badin	5541	21491	15950	15247.40	6669.356	76237	5.1%
Total	0	97434	97434	37430.18	33453.245	1497207	100.0%

Source: author's Calculations based on Development Statistics of Sindh,2021

Table 4. Production analysis of cotton crop during 2015-16 to 2019-20 in 8 districts of Sindh Province

(Production in bales)

District Name	Minimum	Maximum	Range	Mean	Std. Deviation	Sum	% of Total Sum
Ghotiki	493936	612952	119016	565455.60	45014.829	2827278	32.6%
Khairpur	348950	478782	129832	411779.40	50076.265	2058897	23.7%
SBA	212209	392921	180712	334146.80	71443.622	1670734	19.3%
Mirpurkhas	201889	260995	59106	225587.80	25647.810	1127939	13.0%
Larkano	0	10169	10169	6514.20	3826.175	32571	0.4%
Dadu	42811	71336	28525	58233.40	10680.426	291167	3.4%
Tando Muhammad Khan	15035	132735	117700	62207.00	59941.524	311035	3.6%
Badin	22089	99912	77823	70715.20	33339.521	353576	4.1%
Total	0	612952	612952	216829.92	196159.205	8673197	100.0%

Source: author's Calculations based on Development Statistics of Sindh, 2021

Table 5. Area analysis of sugarcane crop during 2015-16 to 2019-20 in 8 districts of Sindh Province

(Area in hectares)

District Name	Minimum	Maximum	Range	Mean	Std. Deviation	Sum	% of Total Sum
Ghotiki	50236	59168	8932	55399.40	4637.538	276997	30.4%
Khairpur	21466	22762	1296	22157.00	569.583	110785	12.2%
SBA	28935	35705	6770	32324.00	2686.593	161620	17.8%
Mirpurkhas	12456	18900	6444	17041.20	2744.107	85206	9.4%
Larkano	703	718	15	710.00	6.205	3550	0.4%
Dadu	4500	6926	2426	5921.40	1044.046	29607	3.3%
Tando Muhammad Khan	13785	20613	6828	17582.20	3169.900	87911	9.7%
Badin	14670	42600	27930	30969.80	14131.378	154849	17.0%
Total	703	59168	58465	22763.13	16990.762	910525	100.0%

Source: author's Calculations based on Development Statistics of Sindh,2021

Table 6. Production analysis of sugarcane crop during 2015-16 to 2019-20 in 8 districts of Sindh, Province

(Production in Mt

District Name	Minimum	Maximum	Range	Mean	Std. Deviation	Sum	% of Total Sum
Ghotiki	2929661	4415803	1486142	3684167.00	534064.290	18420835	33.3%
Khairpur	1220027	1446172	226145	1330483.60	97973.555	6652418	12.0%
SBA	1787532	2470458	682926	2085170.20	258888.472	10425851	18.9%
Mirpurkhas	677160	1195345	518185	985475.40	204049.817	4927377	8.9%
Larkano	38913	80138	41225	52254.60	16106.788	261273	0.5%
Dadu	240191	367332	127141	303736.40	47040.613	1518682	2.7%
Tando Muhammad Khan	803913	1303982	500069	1079990.00	233420.497	5399950	9.8%
Badin	745725	2535088	1789363	1534484.20	784015.853	7672421	13.9%
Total	38913	4415803	4376890	1381970.18	1124308.371	55278807	100.0%

Source: author's Calculations based on Development Statistics of Sindh,2021

Table 7. Impact of temperature humidity and rainfall on crop productivity in Sindh

Crop	Variable	Coefficient	Std. Error	t-Statistic	Prob.
Wheat	Maximum Average Temperature	526.6994	120.0436	4.387566	0.0005
	Minimum Average Temperature	-412.05	176.051	-2.34052	0.0335
	Average Percipitation	1.529059	5.590857	0.273493	0.7882
Cotton	Maximum Average Temperature	201.4549	92.06862	2.188095	0.0449
	Minimum Average Temperature	-125.129	135.024	-0.92672	0.3687
	Average Percipitation	2.545181	4.287961	0.593564	0.5616
Sugarcane	Maximum Average Temperature	4448.032	2215.595	2.007602	0.0631
	Minimum Average Temperature	-1599.71	3249.299	-0.49232	0.6296
	Average Percipitation	82.33401	103.1881	0.797902	0.4374

Source: author's Calculations based on Development Statistics of Sindh, 2021

Tables 3 and 4 indicate that the yield of cotton 8,673,197 bales, swon on an area of 1,497,207 hectares in 8 districts of Sindh province from 2015-16 to 2019-20. The cotton production remained as in the districts of Ghotki 2,827,278 bales (32.6%) Khairpur, 2,058,897 bales (23.7%) SBA 1,670,734 bales (19.35%), Mirpurkhas 1,127,939 (13.0%). The cotton crop less produced in the districts of Larkano, Badin, Dadu and Tando Muhammad Khan 32,571, 291, 167, 311035 and 353,576 bales respectively. The average yield of cotton 216,829.92 bales against average cultivation of area 216,829.92 hectares.

Tables 5 and 6 denote the situation of sugarcane crop produced in 8 districts of Sindh province during the period from 2015-16 to 2019-20. Total sugarcane production recorded 55,278,807 Mt cultivated on an area of 910,525 hectares. The productivity remained in Ghotki (18,420,835 Mt, 33.3%), Khairpur (6,652,418 Mt 12.0%) Mirpurkhas (4,927,377 Mt 8.9%) and SBA (10,425,851 Mt 18.9%). The less product of sugarcane was recorded in the districts of Larkano, Dadu and 0.5, 2.7% respectively. The average product of sugarcane observed 1,381,970.18 Mt against average cultivation area of 22,763.13 heactares in these districts during the study period.

Data analysis

In Case of cotton the coefficients and the probability values also show the significant effect of the Maximum Average Temprature on the

productivity of the cotton. While the percipitaiton level doesnot show significant effect of the temperature and the precipitation. Similiarly the coefficients and the probability values of the model show the significant effect of the maximum average temprature on the productivity of the sugarcane. While the percipitaiton level doesnot show significant effect of the temperature and the precipitation. While the percipitaiton level doesnot show significant effect of the temperature and the precipitation.

The time series data of the Temperature and Precipitation were used to find the relationship through regression model. The results show different levels of impact of the temperature (Maximum and Minimum Average Temprature), on the productivity of wheat, cotton and sugarcane in the province of Sindh as shown in (Table 7). While rainfall (Average Percipitation) did not show significant effect on the productivity of the selected crops. Climate change is considered a great threat to crop production system of major crops such as wheat, cotton, and sugarcane. It was predicted that by the end of the century temperatures to have risen 5-6°C that will cause up to 50% loss of wheat productivity (Ghanem, 2010) in Asian countries including Pakistan due to its geographical position. Siddiqui et al., were evaluated the impact of climate change on Wheat, Rice, Maize, Cotton, and Sugarcane of Pakistan and reported that these crops will be significantly affected by alarming increase in temperature (Gijsbertsen et al., 2017). The effect of climate change varies from one crop to another as cotton is one of the most affected crops (Davidson, 2018).

CONCLUSION

On the basis of above findings, it is concluded that, major crops production were affected by environmental issues like temperatures and differences areas under cultivation. The regression results of the time series data shows that the maximum temperature showed positive impact on wheat, cotton and sugarcane production while minimum temperature was not favourable in respect of all crops. While precipitation level shows an overall insignificant effect on the productivity of the selected crops. Providing certified seeds, fertilizers, supply of water, credit facilities, and infrastructure's development could increase the amount of agricultural productivity in Sindh province as well as in the country.

AUTHOR'S CONTRIBUTION

A. A. Joyo: Conceptulizatin of research idea, data collection.

Z. H. Channa: Data analysis and wrote initial draft of manuscript.

M. B. Khan: Data collection and manuscript reviewed.

A. S. Joyo: Analyzied the collected data.

N. A. Bhutto: Helped in statistical analysis.

REFERENCES

Agriculture Statistics of Pakistan 2019-20. Pakistan Bureau of Statistics, Government of Pakistan, Islamabad www.pbs.gov.pk/ agriculture- statistics-tables

Ali, S., Y. Liu, M. Ishaq, T. Shah, A. Ilyas and I. U. Din. 2017. Climate change and its impact on the yield of major food crops: Evidence from Pakistan. Foods, 6 (6): 39.

Ali, U., W. Jing, J. Zhu, Z. Omarkhanova, S. Fahad, Z. Nurgazina and Z. A. Khan. 2021. Climate change impacts on agriculture sector: A case study of Pakistan. Ciência Rural, pp. 51.

Aslam, M. 2016. Agricultural Productivity Current Scenario, Constraints and Future Prospects in Pakistan. Sarhad Journal of Agriculture, 32 (4): 289-303.

Cradock-Henry, N. A., P. Blackett, M. Hall, P. Johnstone, E. Teixeira and A. Wreford. 2020. Climate adaptation pathways for agriculture: Insights from a participatory process. Environmental Science and Policy, 107: 66-79.

Davidson, D. J. 2018. Rethinking adaptation: Emotions, evolution, and climate change. Nature and Culture, 13 (3): 378-402.

Food and Agriculture Organization of the United Nations. 2019. Agriculture and Climate Change: Challenges and Opportunities at the Global and Local Level: Collaboration on Climate-Smart Agriculture. Food and Agriculture Organization of the United Nations.

Ghanem, H. 2010. Addressing food insecurity in protracted crises. Food and agriculture organization of the United Nations.

Gijsbertsen, C., M. Kuiper, L. Borst, I. van der Horst and H. van Veldhuizen. 2017. Water management and irrigation near Za'atari Refugee Camp–Jordan. SamSam Water, VNG International and City of Amsterdam.

GoP, 2016. National Environment Report (Pakistan Environmental Protection Agency), Ministry of Climate Change, Islamabad.

GoP, 2021. Pakistan Economic Survey, 2020-21, Finance Division, Islamabad.

GoP, 2022. Pakistan Economic Survey, 2021-22, Finance Division, Islamabad.

GoS, 2022. Development Statistics of Sindh, 2021. Bureau of Statistics, Planning and Development Department, Government of Sindh, Karachi.

Haq, S. U., I. Boz and P. Shahbaz. 2021. Adoption of climate-smart agriculture practices and differentiated nutritional outcome among rural households: A case of Punjab province, Pakistan. Food Security, 13: 913-931.

Janjua, S., I. Hassan, S. Muhammad, S. Ahmed and A. Ahmed. 2021. Water management in Pakistan's Indus Basin: Challenges and Opportunities. Water Policy, 23 (6): 1329-1343.

Japan International Cooperation Agency JICA, 2022. Data Collection Survey on Agricultural Sector in Sindh Province in the Islamic Republic of Pakistan.

Kamenev, S. N. 2014. Ehkonomicheskoe razvitie Pakistana, 1947-2012. Makroehkonomicheskij analiz. M., IV RAN.

Kumar, A., D. Yadav, P. Gupta, V. Gupta, S. Ranjan and S. Badhai. 2020. Effects of Climate Change on Agriculture. FASJ010314.

Kurukulasuriya, P., R. Mendelsohn, R. Hassan, J. Benhin, T. Deressa, M. Diop and A. Dinar. 2006. Will African agriculture survive climate change? The World Bank Economic Review, 20 (3): 367-388.

Lohano, H. D., and F. M. Mari. 2020. Climate Change and Implications for Agriculture Sector in Sindh Province of Pakistan. Mehran University Research Journal of Engineering and Technology, 39 (3): 668-677.

Mahato, A. 2014. Climate Change and its Impact on Agriculture. International Journal of Scientific and Research Publications, 4 (4): 1-6.

Moorhead, A., 2009. Climate, Agriculture and Food Security: A Strategy for Change, Alliance of the CGIAR Centers, Washington, USA.

Rasul, G., M. Afzal, M. Zahid and A. A. Sayed. 2012. Climate Change in Pakistan: Focused on Sindh Province, Pakistan Meteorological Department, Islamabad-Pakistan. Technical Report No. PMD-25.

S. Akbar Zaidi. 2015. Issues in Pakistan's Economy: A Political Economy Perspective, Oxford University Press, Karachi.

Saif, U. 2017. Climate Change Impact on Agriculture of Pakistan-A leading Agent to Food Security. International Journal of Environmental Sciences and Natural Resources, 6 (3): 76-79.

Shakoor, U., A. Saboor, I. Ali and A. Q. Mohsin. 2011. Impact of Climate Change on Agriculture: Epirical Evidence from Arid Region. Pakistan Journal of Agriculture Science, 48 (4): 327-333.

Sheikh, M. J., A. A. Narejo, G. M. Khushk and H. Magsi. 2019. Influence of Climate Shifting on Agricultural and Daily Life Activities in Lower Sindh Province of Pakistan. Pakistan Journal of Agriculture, Agricultural Engineering and Veterinary Sciences, 35 (2): 113-118.

Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. Averyt and H. Miller. 2007. IPCC fourth assessment report (AR4). Climate change, 374.

Syed, A., T. Raza, T. T. Bhatti and N. S. Eash. 2022. Climate Impacts on the Agricultural Sector of Pakistan: Risks and Solutions. Environmental Challenges, 6: 100433.

Ul. Hasan, F., B. Fatima and M. Ashraf. 2021. Challenges to irrigated crop zones of Punjab and Sindh Provinces in the Wake of Climate Variability. International Journal of Environmental Science National Research, 27 (2): 556207.

Winston, H. Y. 2013. The Indus basin of Pakistan: The impacts of climate risks on water and agriculture. World bank publications.

ZTBL, 2020. Crop Yield Gap Analysis Pakistan, Planning and Research Department of Zari Taraqiati Bank Limited.

(Received: May 12, 2023; Accepted: December 11, 2023)